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The SUMMER SESSION for 1890 will commence on Monday, April 28th, and continue until July 4th.

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Original Communications.

ELECTROLYSIS IN SURGERY.*

BY ROBERT NEWMAN, M.D., NEW YORK.

Of late it has become a fashion to lecture on the progress of the future. In a temporary mood of enthusiasm, during a lecture delivered fifteen years ago, I predicted and anticipated the progress of electricity in general in such a way that everybody considered it romancing, as a good joke. How far I was then behind the reality, nobody, myself included, had the faintest idea, and what are now accomplished facts, nobody would have thought possible in those days. For instance, the telephone, phonograph, incandescent light for illuminating streets, dwellings, railroads, steamboats, and cavities of the human body; the motor for railroads, factories, and the application in surgery.

Therefore, knowing how I have failed in predicting the progress of the future, I will confine myself to some remarks of the day. As the field is too large, and another paper on "Electricity in Gynæcology" is on your programme, I will make my text more on "Electrolysis in Surgery."

Electrolysis is the decomposition of a compound body by electricity—a chemical decomposition. The body to be decomposed must possess certain elements to be an electrolyte, and as a compound body, must contain water and a salt.

*A paper read at the meeting of the Ontario Medical Association in Toronto, June 6th, 1889.

Nicholson and Carlisle discovered this process of electrical decomposition in 1800, and successfully electrolysed water into oxygen and hydrogen, therefore the theory is not new, and the explanation can be found in any text-book on elementary physics and chemistry. Only the galvanic current can be used for this purpose.

The art in applying electrolysis successfully in surgery consists in:

1. Using the correct strength of the electric current.

2. Applying the respective poles in the right place.

3. Selecting the size, shape, and material of the electrode.

4. Regulating the *duration* and intervals of seances.

Electrolysis applied with a mild current will cause absorption only—a galvanic, chemical absorption—while a strong current will burn, cauterize, or even destroy tissues. Therefore the operator must know what effect he wishes to produce, and graduate the strength of his current accordingly. The management of the operation must be such that every possible mishap is anticipated and prevented.

The first necessity is to see that the galvanic battery is in perfect working order, and for this the following tests can be made. To illustrate, Dr. Charles R. Dickson, of Toronto, has kindly furnished me with a galvanic battery, and will assist me in these experiments demonstrating and executing the text which I am explaining.

TESTS FOR THE ACTIVITY OF THE GALVANIC BATTERY.

After the elements have been immersed in the fluid, and the electrodes moistened (best with hot water, to which a little table salt may be added), we are ready for the demonstration of the tests, which are as follows:

1. *Taste and sensation:*

(*a*) Taste.— A weak current is used, of a few cells only. One electrode being held in the hand, the other placed on the tongue, a coppery taste is experienced.

(*b*) Sensation. — With a stronger current, one electrode in the palm of the hand, the other sponge electrode touching the dorsum of the same hand will cause contraction of the muscles and a prickling sensation.

2. *Spark test:*

Touching for a moment the two electrodes, a spark will be seen distinctly, if the battery is in working order. The best materials to illustrate this experiment are a platinum needle for one pole, and carbon for the other, as you will observe we have here.

3. *Galvanoscope:*

If the electrodes touch each other the needle will show a deflection.

4 *Mille-ampère meter:*

Needle will move if an electrolyte is brought into the circuit.

5. *Water test:*

If the two electrodes in the shape of platinum needles are immersed in water, bubbles will arise, particularly around one pole.

The action of the poles is very different in electrolysis, hence each has its own function.

The *positive* pole attracts the acids, and the oxygen from the tissues coagulates blood.

The *negative* pole attracts the alkalies, hydrogen, and the base of the salt, dissolves blood (but forms a plug from froth of the hydrogen), coagulates albumen and causes absorption.

Hence the positive pole acts like an acid, and burns like fire, which is not only exceedingly painful but may leave a hard resilient cicatrix. On the other hand the negative pole acts more like a caustic alkali, which does not hurt so severely during the application, and leaves, if carried to excess, a cicatrix which is soft and not retractile. From this it is evident that for the immediate destruction of tumors and for strictures the negative pole should be selected. Electrolysis requires the presence of water, and that you will find in every tissue.

As it is most important to distinguish the poles, and as we cannot trust to the marks of the instrument maker, we must always ascertain which is the positive and which the negative pole.

TESTS FOR THE IDENTITY OF EACH POLE.

We have five principal tests which we will now demonstrate with Dr. Dickson's kind assistance.

1. *Water test.*—The simplest and best method is to repeat the last experiment which we made for testing the battery. Immerse two electrodes in the form of platinum needles in water, and you will see the hydrogen at the negative pole, which shows itself in distinct bubbles like pearls around and above the needle, sparkling almost like carbonic acid in an effervescent.

2. *Meat test.*—The poles of the battery in the shape of two needles (platinum are best) are inserted in a piece of raw fresh meat. After the electrolytic action has been allowed to take place for a while, the difference in pole action can readily be observed. To save time we have electrolysed a piece of meat a few hours ago, in different places, with a variety of current strengths, the result of which is here for your inspection. On this side you will find the result of a current of five mille-ampères, with four cells of the battery for five, ten, and twenty minutes respectively. On the other side of the meat a current of fifty-five mille-ampères was used for five seconds, five, and twenty minutes. The insertion of each pole is labelled, so that you can see and study the effect of the current and of the pole. You will find an effect from a current of even five seconds duration; you will see that the positive pole has made the meat black around the needle, almost charred and destroyed it, while at the negative pole you will observe the color different, nearly white, as also again the bubbles of the hydrogen.

Let us try now the same experiment before you, and here again you can see the bubbles of the hydrogen, observe a white color, and even hear a hissing sound all around the negative pole, while the positive pole is noiseless, blackens the color, and the litmus paper applied to it shows an acid reaction.

A piece of fresh meat still contains water enough to be an electrolyte, while the living body in which the circulation is active, is better, and a dried up piece of meat is no electrolyte.

Practical experiments I have made on dogs, also on pieces of meat and pathological specimens, particularly with carcinoma. From among them I will mention the following:

(*a*) Into a piece of raw fresh pork two large platinum needles were inserted, at a distance of three inches. The current from a galvanic battery of thirty-five cells was allowed to pass for fifteen minutes, after which time the meat between and around the needles was thoroughly changed into a soft pulp. A weaker current caused changes accordingly; the current of five cells produced distinct effects in five seconds, twenty cells in one second.

(*b*) Into a piece of meat containing a bone in its centre the needles were inserted at a distance of two and a-half inches from each other. One large platinum needle was then connected with the positive pole, while with the negative pole two small steel needles were connected. These needles were inserted close to the bone, and one directly into the bone cells. The galvanic current of thirty-five cells in fifteen minutes produced changes in the entire tissues, so that even the bone around one negative needle was entirely destroyed.

3. *Decomposition of a salt.*—If, for instance, a solution of iodide of potassium be subjected to electrolysis, one equivalent of iodine liberated at the positive, will have one equivalent of hydrate of potassium liberated at the negative pole, showing that the potassium liberated from combination with the iodide has combined with some of the surrounding water. This can be illustrated by simply holding both poles in the solution, while the galvanic battery is in action.

The experiment, however, which we will now make before you is more strikingly demonstrative and I believe is original with me. These two small glass vials we have filled with a solution of iodide of potassium. The bottoms of the vials are substituted by a piece of pig's bladder, the necks are then stopped by a cork, through which runs a platinum wire, one end of which is immersed in the solution, and the other attached to a pole of the galvanic battery.

Both vials so closed are now placed in a dish of water; they are six inches distant from each other. There is, as is seen, no communication between them except the water, and so long as the battery is at zero, you will see no change in the solution, which is transparent and undisturbed. Please notice the change which now takes place as soon as the battery begins to act. We begin with only six cells, and you will notice almost immediately in the vial connected with the positive pole, that in the clear solution streaks of yellow appear, and in about five minutes the vial contains only a dark yellow fluid, which is the iodine set free at this pole. At the negative pole the contents of the vial remain clear, only the bubbles of froth welling up. This is the hydrogen set free from the water. The result of this electrolysis is iodine, oxygen, and hydriodic acid at the positive pole, while at the negative pole we find hydrogen and potassium.

If this same experiment is tried with a Faradic battery, as I have often verified, no change whatever takes place in the solution. This is another proof that the action of the galvanic current is widely different from that of the Faradic, and that for electrolysis a galvanic current only can be used.

4. *Test by Galvanoscope (or Mille-ampère Meter).*—If the two electrodes are brought in contact with each other the needle will deflect towards the positive pole.

5. *Stammer's Polarity Distinguisher*—Is a simple and practical test. It is constructed on the principle discovered by Oersted, that the magnetic needle tends to assume a position at right angles to the direction of the electric current. This little instrument shows the positive pole by the appearance of the red color in either fenestrum as soon as the poles are held in contact with the instrument.

SIZE AND MATERIAL OF ELECTRODES.

The *size* of the electrodes will concentrate or diminish the force of the electricity accordingly; therefore, an electrode of large size is indicated if the respective pole is used merely to close the circuit, etc.

The *material* of the working electrodes may be metal, as brass, copper, lead, nickle, silver, gold, platinum; while the material for the electrode to close the circuit only may be

sponge, clay, carbon, or brass, covered with absorbent cotton or other suitable fabric.

The *shape* of bulbs may be acorn, olive, egg, flat, round, long; and needles of different shapes and sizes are used.

The *manner* of applying electrolysis is two-fold:

1. One pole is used for effecting the electrolysis, and the other pole is indifferent, only to close the circuit.

2. Both poles are inserted as working electrodes, as in the case of tumors, when both poles in the form of needles are used. In either case the poles may be constructed in one piece, or divided into different points. If divided each point will do the work in proportion to its subdivision.

MEASUREMENT AND UNITS OF ELECTRICITY.

At the present time of progress it is imperative to measure currents used for electrolysis. The mille-ampère meter is the instrument used for that purpose. For a better understanding, and to make this part of the paper more complete, a brief mention of units in electric nomenclature is here in place. The term "legal" is applied to the units adopted by the Paris Electric Congress in 1881, hence the following are the practical legal electric units, based on the C.G.S. system.

A *Volt* is the unit of electro-motive force, the measure for pressure of difference of potential. It is nearly equal to one cell of Daniell's battery.

The *Ohm* is the unit of resistance, or rate of velocity, the standard of which is a column of pure mercury one square millimeter in cross section, and 106 centimeters in length, at the temperature of 0° C.

An *Ampère* is the unit of current strength or volume; the standard measure of the electric current. An ampere is equivalent to the strength furnished by an electro-motive force of one volt, passing through a resistance equal to one ohm $\left(C = \frac{E}{R}\right)$.

A *Coulomb* is the unit of quantity. It is equal to one unit of current ampere passing in one unit of time (one second); or in other words a current of one ampere in a circuit will produce one coulomb in a second.

A *Watt* is the unit of energy or force, or equal to a combined volt and ampere. One horse power $= \frac{\text{Amp. x Volt}}{746}$.

A *Farad* is the unit of capacity. It represents the storage of one coulomb of electricity in a condenser.

A *Joule* is the unit of heat; it also represents the work done by a watt in a second.

Manifold are the practical uses of electrolysis in the different branches of surgery. I will mention only some in a cursory manner without going into their details, description, or systematic order. The field is too large, and the time allowed too short, being some of the reasons that compel briefness.

Aneurism.—The first cure is reported by Petriquin as far back as 1845 (*Bulletin Gén. de Thérap.*, Vol. XXXI). Many other cases are reported; among them, however, are a large percentage of failures. More recently better results have been obtained, so that out of eighty-nine cases thirty-two cures have been reported, one of which was an aneurismal tumor of the external iliac. Dr. Bowditch reports one case of aneurism of the aorta improved in 1876 (Boston *Med. and Sur. Jour.*, No. 2, 1876). Among other operators are Ciniselli, Dujardin-Beaumetz, Laurent Robin (Robin, De l'Electroponcteur dans la Cure des Anéurysmes, Intrathoraciques, 1880), Sands, Lincoln, Levis, Pepper, Heath (*Lancet*, Jan. 31, 1883), Francisco Brancaccio reports one successful case (*Revista Internaz. di Med. e Chir. Napoli*, 1884, I., pp. 73-79). Prof. Saboia, one case, unsuccessful (*Med. Press*, May 19, 1886). Olelar, one case, temporary relief (Boston, *Med. and Surg. Jour.*, Oct. 20, 1887).

Varicocele.—In varicocele I have had cures and failures, according to the different cases, patients, and methods employed.

Nævi and Port Wine Marks.—The use of electrolysis in nævi and port wine marks has resulted probably in many more failures than successes, and galvano-cautery acts in general better in these cases. However (Beard in *Archives of Elect. and Neurolog.*, Vol. II., No. 1), Bartholow says: "Polypi, nævi, sebaceous tumors, and similar new formations are promptly cured by electrolysis." Hardaway, of St. Louis, has had success with a single needle in port wine marks. Duncan reports eleven successful

cases to British Medical Association (*Med. Record*, Sept. 15, 1888). Lewis W. Marshall reports on nævi (*Lancet*, N.Y., Feb. 1889).

Epilation.—Dr. C. Heitzmann, in a paper read before the American Dermatological Society, Aug. 27, 1885, extols electrolytic epilation. Other favorable reports are from G. H. Fox (*N. Y. Med. Rec.*, March 22, 1879), A. D. Rockwell (*N. Y. Med. Jour.*, Oct. 13, 1883), H. Montague, Detroit (*Times and Register*, May 18, 1887), G. H. Rohè (*Atlanta Med. and Surg. Jour.*, July 1, 1888). For the electrolysis of nævi and removal of superflous hair, W. E. Stevenson (*Provincial Medical Journal*, Dec. 1888), uses platinum needles with the positive pole.

Spermatorrhœa.— This is reported on by Richard Wagner, of Blankenburg, Berlin Klinische Wochenschrift (*Med. Register*, Oct. 6, 1888).

Hydrocele.—Cures by single or by repeated applications have been reported by Althaus, Frank (*Archives of Elect. and Neurol.*, Vol. I., No. 2), Rodolfi (*Practitioner*, Sept. 1873), Erhardt (*Allgem Med.*, *Central-Zeitung*, 99, 1874), Bartholow (Medical Electricity, 1881). The principal method recommended consists in evacuating the fluid, then introducing two needles into the tunica vaginalis, where the electrolytic action is carried on. Variations of this method may be made. Failures take place just as well as with other means.

Subcutaneous Erectile Tumors.—These have been successfully treated by W. T. Hutchison, of Providence (*Archives of Elect. and Neurol.*, Vol. II., No. 1), M. Bories, of Montainbau (*Revue de Therap.*, April 15, 1888), Redard (at the Meeting of Societé Medicale des Hospitaux, Paris, *Jour. Amer. Med. Assoc.*, Sept. 15, 1888).

Ganglions.—Ganglions, or weeping sinews, have been cured by David Prince, of Jacksonville, Ill., thus: "A needle introduced through the little tumor which encloses the gelatinous accumulations around a tendon, and held there only a few seconds until some apparent action has been induced, leads generally to a speedy disappearance of the tumor without slough or suppuration."

Ranula.— In ranula the electrolysis decomposes the contents of the sac, coagulates, or destroys it. I have had a few cases.

Hernia.—The radical cure of hernia by electrolysis, originated with Dr. J. Craft, of Cleveland, who has had success with the method. After reducing the hernia, he closes the inguinal canal by inserting a positive needle electrode, properly insulated except at the tip, between the internal and external rings, using a current strong enough to excite adhesive inflammation.

Hemorrhoids.—Hemorrhoids have also been successfully treated by Dr. Craft, who writes: "In hemorrhoids I apply the positive needle also, yet in a few cases I have applied the negative, but do not get such decided cicatrizing and shrivelling up of the pile, as with the positive. I select the particular pole according to the peculiarities of each individual case. If I want to absorb the pile I use the negative; if I desire to seal up the vessels by adhesive inflammation, I use the positive needle."

Tumors.—Tumors of all kinds give a wide field for the employment of electrolysis. The sanguine reports of some operators are contradicted by return of the malady and other unsuccessful cases. However, the successes of undoubted cases should stimulate the continuation of treatment in this direction in order to establish good methods. Dr. A. C. Garrett, of Boston, reported to the Ninth Internat. Med. Congress, in Washington, 184 *tumors of the breast*, treated by galvanism, from 1864 to the present time, of which 157 were cured. M. Meyer, in Berlin, absorbed a large callus at the elbow of a boy, and motion was restored. It required 118 sittings.

Good results have been reported in *enlarged sub-maxillary glands*, by Davis (Philadelphia *Med. Times*, Oct. 2, 1871).

Goitre.—Morrell Mackenzie, in a paper on bronchocele, says he cured by electrolysis nine cases out of thirteen. C. R. Dickson, of Toronto, has had good results in several cases. Of the cystic variety cures have been reported by Amussat (*Bull. Gén. de Thérap.*, Oct. 15, 1872), Ultzman (*Wiener Med. Presse*, No. 26, 42, 1872), Smith (*Med. Record*, Aug. 7, 1875), Althaus (*Brit. Med. Jour.*, Vol. II,, 1875).

Of the solid variety cures have been reported by Wahltuch (*Med. Times and Gazette*, Jan. 28, 1879), A. D. Rockwell (*Med. Record*, Jan. 17, 1884), Duncan (Report to British Medical Association, *Med. Record*, Sept. 15, 1888).

G. C. Pitzer, St. Louis, reports great success (*Chicago Med. Times*, May, 1888). J. B. Green, of Mishawaka, Ind., reports in a private communication. G. Rohè, of Baltimore, reports success in several cases to Clinical Society of Maryland. Weinbaum, of Kovel, reports two cases in Vratch (*Jour. Amer. Med. Assoc.*, Oct., 27, 1888).

Malignant Tumors (including ephithelioma, carcinoma, and sarcoma).—With these diseases I have had considerable experience, the results varying in both directions. While some patients succumbed to the disease, others were permanently cured. One case, particularly, has been reported to the Pathological Society, New York, in which the history and diagnosis were fortified by specimens and microscopical slides, which removed any doubt about the correctness of the statement (Newman, *Medical Record*, Dec. 24, 1881. Among other favorable reports, I mention W. H. Mussey (*Transactions Amer. Med. Assoc.*, 1872), A. D. Rockwell (*Archives of Elec. and Neurol.*, Vol. I., p. 74), Neftel (*Virchow Archives*, Vol. LXX., p. 171), Neftel (*N. Y. Med. Record*, Sept. 1st, 1869). J. T. Parsons details in *Brit. Med. Jour.* four cases treated with powerful galvanic currents 600 mill.-amp. (*Times and Register*, May 25, 1889).

Nasal and Pharyngeal Neoplasms.—"Electrolysis in the Removal of Nasal and Pharyngeal Neoplasms," by D. G. Campbell, is an excellent theoretical article, explaining the electrolytic action, and different dosages needed (*Jour. Amer. Med. Assoc.*, Aug. 25th, 1888). Bruns reports good results in nasal polypi (Berlin *Klin. Wochenschrift*, No. 27, 28, 1872; No. 32, 1873).

Pseudo-Membranous Laryngitis.—A case is reported by F. E. Waxham, in which the patient died (*Jour. Amer. Med. Assoc.*, Jan. 1st, 1887).

Prostate.—In disease of the prostate gland and seminal ducts, great caution is required in order not to cause an inflammation or overstimulation of the parts. There is no doubt that with care in the manipulation of the instruments and the electric current much good can be done. Diminution of senile hypertrophies has been effected by different operators. Five cases have been reported by Biedert, of Hanan (*Berliner Klinische Wochenschrift*); Bryce reports success (*Southern Clinic*); Leopold Casper of Berlin, treated fourteen cases of enlarged prostate by electrolysis, applying the negative pole per rectum (*Med. and Sur. Rep.*, July 14th, 1888); J. D. S. Davis, of Birmingham, Ala, reports in *Atlanta Med. and Sur. Jour.*, January, 1889.

Eye and Ear.—C. H. H. Hall, in "Removal of Opacities of the Cornea by means of Galvinism," reports nine cases (*Med. Record*, June 23, 1888). "On a New Operation for Deafness caused by Obstruction of the Eustachian Tube" is the title of a paper by A. E. Cumberbath, F.R.C.S. and W. E. Stevenson, M.R.C.P., London (*The Lancet*, Nov. 24, 1888).

Strictures.—Strictures in different localities of the body have been treated by electrolysis with great benefit. Gorecki's method for *strictures in nasal cavities* has also been used for the *lachrymal canal*, and for the *dilatation of the eustachian tube*, by M. J. Mercie (*Medical News, Quarterly Epitome*, March, 1883, p. 117).

Stricture of the Eustachian Tube. — At a meeting of the Academie de Medicine, March 11, 1884, there was read a note by M. Mercier and M. Garricon, Desarenes, Paris, on the treatment of this affection by electrolysis. The operation consisted in passing a fine silver sound into the eustachian tube, and a small olive-shaped electrode into the external auditory meatus. A feeble current was then passed, the sound gradually pushed on, and the stricture disappears.

Stricture of the Œsophagus. — Œsophageal strictures yield to electrolysis when not malignant; cures have been reported by Frank, Butler, Prince; one successful case by E. T. Painter, Pittsburg (*Med. Register*, Oct. 13, 1888), by twenty-five seances in three months; one case cured by M. Fort, reported to the Academie de Medicine (*Med. Record*, April 6, 1889), one case of tumorous stricture of œsophagus with cure by electrolysis in Transactions of the Michigan State Medical Society, June 15, 1888, by D. S. Campbell, Detroit (*Med. Record*, May 4, 1889); two cases, private report by Dr. Dickman, who writes that he had one unpublished case in June, 1888.

One peculiar case is on record in which electrolysis produced a cure in conjunction with gastrotomy, reported by Professor H'jorth, of Christiania, at the International Medical Congress in Copenhagen. The stricture was caused

by the patient swallowing an alkali. The contraction following was of such a nature that no sound would pass below the cricoid cartilage, and swallowing was nearly impossible. Gastrotomy was resorted to, and electrolysis applied at the part. The current was commenced with five cells, gradually increased to fifteen cells. After one hour the electrode bougie suddenly passed through the stricture. The second application was made after twelve days, after which the stricture was so well cured that the patient could eat and swallow both solids and and fluids, and a Charriére bougie No. 19 passed through the former stricture both ways, from below and above. Two weeks later the gastric fistula was closed by operation. The prognosis in œsophageal stricture is almost always grave. The elaborate statistics by M. Petit, of Paris, of one hundred and fifty-five operations show only two per cent. of cures, and seventy-five per cent. of deaths. Therefore electrolysis in œsophageal strictures must necessarily play an important part in the treatment in future.

Stricture of the Rectum.—Strictures of the rectum have better chances by electrolysis than by other means, provided they are not malignant. I have prepared a paper on this subject for the next meeting of the American Medical Association which will be held this month in Newport. I have to report twelve of my own cases with nine permanent cures and three relieved, as also successful cases of Dr. S. T. Earle, of Baltimore; Samuel Benton, M.D., and W. T. Whitmore, M.D., of London.

Stricture of the Female Urethra.—Strictures of the female urethra are rare, but they occur occasionally and are readily cured (Newman, *Americal Journal of the Medical Sciences*, Oct. 1875).

Atresia Vaginæ.— In 1872 I treated by electrolysis successfully a case which has not been published.

Stricture of the Male Urethra. — Strictures of the urethra have been treated by myself successfully for nearly twenty years, and so many hundred cases are on record, that I did not intend to take up any time here, on this subject; but having seen in this city very imperfect instruments, which have been called, and sold as, Newman's Electrodes, I consider it a duty to show you the original set of electrodes as devised by myself. They consist of four distinct sets, and are manufactured to my perfect satisfaction by the well-known firm of Geo. Tiemann & Co., No. 107 Park Row, New York City.

Fig. 1. Egg-shaped Electrode.

1. The Egg-shaped Set. — The regular electrodes for all ordinary cases have a short curve, an egg-shaped metallic bulb at the working end; while at the upper end there is a round wire rod for the binding screw of the negative pole of the battery; the only points not insulated and acting as conductors are these extremities. The rest of the electrode must be well insulated, smooth, and without inequalities. I consider a conical bulb objectionable in most cases, as we depend on the electrolytic power of absorption, not on force. The length of the bulb is proportioned to the size of the electrode, thus for No. 11 French the bulb is $\frac{3}{16}$ of an inch, while for No. 21 it is $\frac{3}{8}$ of an inch. The set consists of Nos. 11, 14, 17, 18, 20, 21, 23, 25, 28 of the French scale.

Fig. 2. Acorn-shaped Electrode.

2. The Acorn Set.—These are for use in the first six inches of the urethra in certain cases, and consist of Nos. 15, 17, 20, 22, 25, 27, French. They are without a curve, short, and the bulb is *acorn*-shaped. Sometimes it is desirable to gain ground by entering the contraction first with the point of the electrode, in order to follow easier with the larger part of the

acorn, here this form will do good work. The action of the electrolysis depends on the largest diameter of the bulb in these cases, and does most service on the withdrawal of the electrode when the operator feels best how much work should be done. It is also used when the stricture is near the meatus.

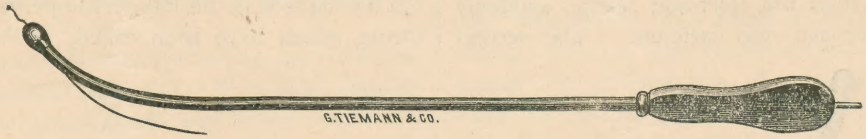


Fig. 3, Tunnelled Electrode.

3. The Tunnelled Electrode.—These are in Nos. 9, 11, 14, 17, 20, 21, French. They are very important for bad, tortuous strictures and are to be used only by the expert operator. The curve is shorter and the egg-shaped bulb tunnelled so that it may be introduced over a filiform guide. They are on the principle of the tunnelled sound invented by Dr. J. W. S. Goulay, and were devised by me so that electrolysis and tunnelled sound could be used simultaneously. Where the stricture was impassable with ordinary instruments this was used successfully, and passed through the stricture without the possibility of making false passages.

4. The Combination Electrode.—This is tunnelled electrode and catheter in one. It is an auxiliary electrode for extreme cases. Where a very tight stricture is complicated with retention of urine the indications are to remove the obstruction and draw off the water with one instrument, as the parts are too sensitive to tolerate the introduction of two instruments in succession. Also the patient may be benefitted by washing out the bladder, all of which can be done with one introduction of the instrument.

The armamentarium is completed by a few binding screws, some whalebone bougies, olive-pointed whalebone filiform guides, a galvanic battery, conducting wires, sponge electrode, and a mille-ampère meter. The bougie à boule is a good instrument for examining the urethra and detecting strictures.

Details of the operation and further explanation of the electrodes may be found in "Ten Years' Experience in the Treatment of Stricture of the Urethra by Electrolysis," in the *Medical Record*, August 12 and 19, 1882, and "The Armamentarium for the Treatment of Urethral Strictures by Electrolysis," in the *Medieal Register*, Philadelphia, 1887, but the following is a summary of general rules to be observed:

1. Any good galvanic battery will do which has small elements and is steady in its action; the 20-cell battery zinc and carbon elements is an excellent instrument and sufficient for the beginner.

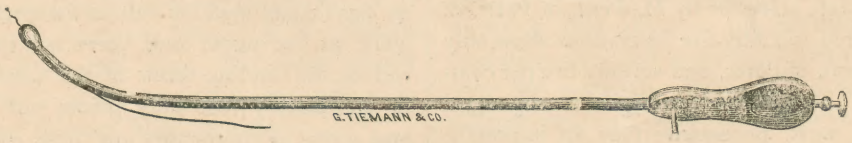


Fig. 4. Combination Electrode.

2. The fluid for the battery ought not to be used too strong.

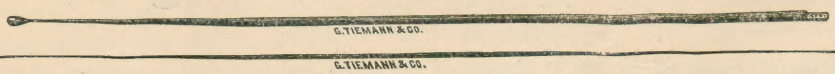
3. Auxiliary instruments are important to the expert, but not necessary for the beginner. However, a mille-ampère meter is desirable.

4. For the positive pole a carbon electrode is used, covered with sponge, moistened with hot water and held firmly against the cutaneous surface of the patient's hand, thigh, or abdomen.

5. For the absorption of the stricture the negative pole must be used.

6. Electrode bougies are firm sounds, insulated with a hard baked mass of rubber. The extremity is a bulb, egg-shaped, which is the acting part in contact with the stricture.

7. The curve of the electrode is short; large curves are mistakes.



Whalebone Bougie.

Filiform Guide.

8. The plates must be immersed in the fluid before the electrodes are placed on the patient, and raised again after the electrodes have been removed.

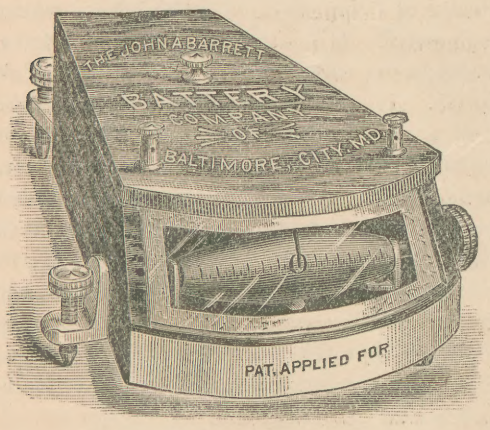
9. All operations must begin and end while the battery is at zero, increasing and decreasing the current slowly and gradually by one cell at a time, avoiding any shock to the patient.

10. Before operating, the susceptibility of the patient to the current should be ascertained.

11. The problem is to absorb the stricture, not to cauterize, burn, or destroy tissues.

12. *Weak currents* at *long* intervals.

13. In most cases a current of six cells, or from two and a half to five mille-ampères, will do the work, but it must be regulated according to the work to be done.



Mille-ampere Meter.

14. The *séances* should be at intervals, not too frequent in succession, about once a week average; and lasting from five to twenty minutes.

15. The best position for the patient to assume during the operation is that which is most comfortable to himself and to the operator. I prefer the erect position, although the recumbent or others may be used.

16. Anæsthetics I like to avoid; I want the patient conscious, so that he can tell how he feels.

17. Force should never be used; the bougie must be guided in the most gentle way; the electricity alone must be allowed to do the work. Avoid causing hæmorrhage.

18. During one *séance* two electrodes in succession should never be used.

19. All strictures are amenable to the treatment by electrolysis.

20. Pain should never be inflicted by the use of electrolysis; therefore it should not be applied when the urethra is in an acute, or even sub-acute inflammatory condition.

21. The electrodes should not be greased with substances which are non-conductors, and would insulate.

22. For ordinary stictures, the size of the bougie selected should be three numbers (French) larger than the stricture.

Since my method has become popular, some instrument makers have sold an inferior and faulty article by the thousands cheap. Some have even manufactured at random instruments which they sell as Newman's Eloctrodes, for which I am not responsible, and deny most emphatically the parentage. Some of these I have seen here in Toronto, with which nobody could perform the operation correctly. For such and many other reasons, it is only a wonder that more failures are not reported.

Electrolysis in Gynæcology is too large a field to enter on this occasion in detail, for reasons given before. However, I consider it my duty to mention that gynæcologists have almost as a unit adopted the practice of electrolysis, and gained thereby wonderful successes. It has been used with success in the following conditions and diseases:

1. *Tumors and Cysts*, principally fibroid and ovarian, *Peri-uterine Hæmatocele, Cellulitis, Peritonitis*, with and without adhesions, including all sub-acute and chronic pelvic inflammations.

2. *Uterine Diseases:* Subinvolution, hyperplasia, stenosis, displacements, menstrual irregularities, chronic cervical catarrh, etc.

3. *Diseases of the Genito-Urinary Organs and Appendages:* Oophoritis, salpingitis, stricture of the urethra, atresia vaginæ.

4. *Extra-Uterine Pregnancy.*

The application and methods vary very much in these diseases, and the question of the day to be solved is the strength of the current, weak *v.* strong currents, either of which has its advocates, and either is applied in extremes.

Coroners' juries proverbially bring in curious verdicts. The latest is by a Pennsylvania jury: An embankment caved in on some railroad laborers, and the verdict was: "Died of Gravel."

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